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Third-Harmonic Performance of the Beamlet Prototype Laser (*)

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ICF target designs for the National Ignition Facility (NIF) demand high-quality beams from the laser driver. Laser entrance holes (LEH's) in the target are designed to be small, on the order of 3 mm or less, to maintain a uniform irradiation environment for the capsule and to minimize radiation transport losses from the hohlraum. Laser radiation incident outside of the LEH must be held to within a few percent to optimize the transport efficiency of the driver, and to minimize plasma blowoff from the edges of the opening that can potentially clip the beams. Therefore the beams must be focused to a diameter that is substantially smaller than that of the LEH. The distribution of irradiance at the walls of the hohlraum is required to be smooth and devoid of "hot spots" that would otherwise drive filamentation and stimulated scattering processes in the plasma and reduce the efficiency of the implosion. Therefore, there is a need to tailor the spatial profile of the focused drive beam and apply some form of temporal smoothing. These requirements are to be met at a total drive energy of 1.8 MJ and a peak power of 500 TW, which it is estimated will produce ignition with a safety margin of two. For the 192 beamlets of the NIF, this translates into an energy of 9.4 kJ and a peak power of 2.6 TW per beamlet.

We are currently conducting tests on the Beamlet prototype laser at Livermore to characterize third-harmonic beam quality and target plane irradiance conditions at high power. Detailed measurements of the nearfield and farfield irradiance distributions both with and without a 16-level kinoform phase plate have been obtained at power levels up to the 3 TW NIF redline for ICF. The functional dependence of the observed beam quality on the principle control parameters in the laser, including output power, B integral, spatial filter pinhole staging, and wavefront precorrection will be discussed and compared against detailed numerical simulations. Recently activated diagnostics provide the additional capability to observe small-scale B-dependent ripple growth in the final focusing optics that can impact the angular distribution of power out to several milliradians . Measurements to quantify these effects at powers up to the 4 TW level prescribed for science-based stockpile stewardship experiments on the NIF are in progress.

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